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*An Account and Description of three PENDULUMS invented
and constructed by JOHN CROSTHWAITE, Watch and
Clock Maker, Dublin.*

FIG. I. represents a pendulum, with a simple mode of compensation, which has now been going eighteen years, much more accurately than could be expected in so very unfavourable a situation: the first ten years against a lath and plaister partition, within three feet of the external wall, and the same distance from a hall-door, the frequent shutting of which must have very much disturbed its vibrations; the last eight years, against an external wall only three feet from the street; which, though a much better situation than the former, yet even here it was liable to have the isochronism disturbed by the carriages almost constantly passing.

Read Nov.
1, 1787.

A and B are two rods of steel forged out of the same bar, at the same time, of the same temper, and in every respect similar. On the top of B is formed a gibbet C; this rod is firmly supported by a steel bracket D, fixed on a large piece of marble E, firmly set into the wall F, and having liberty to move freely upwards
between

between cross staples of brass 1, 2, 3, 4, which touch only in a point in front and rear (the staples having been carefully formed for that purpose); to the other rod is firmly fixed, by its centre, the lens G, of twenty-four pounds weight, although it should in strictness be a little below it. This pendulum is suspended by a short steel spring on the gibbet at C, all which is entirely independent of the clock. To the back of the clock plate I are firmly screwed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining power is applied by a cylindrical steel stud in the usual way of regulators, at M. Now, it is very evident that any expansion or contraction that takes place in either of these exactly similar rods, is instantly counteracted by the other; whereas in all *compensation* pendulums composed of different materials, however just calculation may seem to be, that can never be the case, as not only different metals, but also different bars of the same metal that are not manufactured at the same time, and exactly in the same manner, are found by a good pyrometer to differ materially in their degrees of expansion and contraction, a very small change affecting one and not the other; this, however, is by their framers always tried by the pyrometer, and any defect experimentally remedied by hammering or filing; but it, notwithstanding, requires a length of time, much expence, and an instrument not always accurate. It is very evident, that whenever dissimilar rods are introduced to counteract each other, disorders will take place in the most susceptible, sometime before the remedy is applied by the most tardy, and that this remedy or compensation continues sometime after the occasion for it ceases; and therefore in this country, where the temperature of the atmosphere is subject to such various and sudden changes; when compen-

sations

fations are used, they should be executed with the same materials as that of the pendulum rod, and have exactly the same exposure to the air.

A DESCRIPTION of a pendulum, with a diamond suspension.—
The lens is seven inches diameter, made of lead melted into a brass shell, very accurately weighed in all positions, turned truly in a very steady lathe, first flatwise, and then on an arbor through its centre, and adjusted so that in all situations the centre of gravity of the lens exactly coincides with the axis of the pendulum rod; a piece of brass, half an inch thick and three and an half long by two broad, is let into the lead so as to be even with its surface; four holes being tapped in it to receive the screws c c c c, Fig. II. with their heads countersunk in the brass shell: this piece of brass is hollowed lengthwise on the inside, so as to embrace the pendulum rod, the whole length of itself, but most straightly at its centre. The lens never to be altered after the clock is brought to time. The rod made of red deal, first baked, then boiled in linseed oil for a considerable time, and then well varnished. On the top is formed an irregular octagon and an opening cut through, of the shape of the letter U; there is drilled in the lathe, exactly through its centre lengthwise, a hole to receive the piece of very hard cast steel e, which after being fitted square into a brass collar f, passes through the hole in the upper part of the pendulum rod at 5, and is there firmly secured by a screw, the head of which is countersunk in the top of the rod; at 6 the steel piece is wrought to a fine conical point, on which the whole pendulum is suspended on the well-levelled face of a large diamond; this diamond is set and
C folded

folded with silver into a tempered piece of steel g, having three levelling screws h h h, carefully tapped through it. The points of these tempered screws are rounded and lie in beds formed for them in I, a piece of steel $\frac{7}{16}$ of an inch broad on the upper side; the lower part being rounded, this is very firmly leaded into a piece of statuary marble K, about two hundred weight, firmly inserted in the wall, so as just to admit the steel piece I to pass through the back of the clock case: The pendulum being entirely detached from the clock and suspended on the diamond, and the whole upon the wall. Before the clock was applied, it continued vibrating twenty-seven hours in this detached state as a simple pendulum. I have applied the maintaining power from the movement by a well-tempered and polished steel cylinder $\frac{1}{16}$ of an inch diameter, firmly screwed to the crutch through the opening in the brass collar L; in this opening I have fixed two pieces of sapphire, of which this is the section , the cylindrical sides which the hard steel cylinder above-mentioned acts against being well polished, the contact is lineal. To the back of each of those pieces of sapphire I have fitted two screws o, o, tapped through the brass collar L, which firmly embraces the pendulum rod. By these screws the pieces of sapphire are accurately adjusted to the steel cylinder, so that the power is applied, without the smallest shake or loss of force, exactly in the line of the centres of oscillation, gravity and suspension.

AN account of a clock where the maintaining power is applied immediately from the escapement wheel to the axis of the pendulum rod, without verge, crutch, or any other agent.—I cut a
notch

notch in the pendulum rod deeper than its axis, (see the profile, Fig. III.) and in that opening at k, and in that part on a plate of brass fixed firmly by screws, two pallets r and s, represented larger at Z below, and by the escapement wheel P, with pins 1, 2, 3, 4, 5, 6, &c. made of very hard drawn brass wire instead of teeth, I applied the maintaining power exactly in the line of the centres of magnitude, oscillation, suspension, motion and gravity. This appears to me the most simple and perfect method of applying the maintaining power to pendulums that has hitherto been thought of, and if perfectly executed with ruby or sapphire pallets, and hard steel pins well finished in the wheel, the point of suspension made perfectly immovable, and the maintaining power perfectly uniform, then perhaps the fairest trial may be given to different pendulums.

On shewing my clock made in this way to an ingenious gentleman from London, he told me he saw one executed on the same principles in England. I went to see it, and found it somewhat like mine, but the maker had not those matters in view that I had, as he did not communicate the power at the centre of the rod, but on its external part, by which means much of the power was lost, and the remainder gave the pendulum an undulatory motion which added considerably to the friction, and totally destroyed the isochronism *.

* Since these clocks were made, I constructed another very simple one, in which I made the pendulum to vibrate at right angles with the plane of the escapement wheel: this method promises some material advantages, particularly in large clocks.